Development of The Transparentwinged Plant Bug, *Hyalopeplus pellucidus* (Stål)[1], A Pest of Cultivated Guava in Hawaii[2]

RONALD F. L. MAU[3] and KATE NISHIJIMA[4]

ABSTRACT

The life cycle of the transparentwinged plant bug, *Hyalopeplus pellucidus* (Stål), was studied on guava, *Psidium guajava* L.. Eggs were deposited in stems, flower buds, and leaf midribs and hatched in an average of 7 days. The 5 nymphal stadia were completed in an average of 14 days. The nymphs were anthophagous, and feeding on flower buds was necessary for normal development. Cage studies showed a direct relationship between feeding injury and the abscission of guava flower buds.

During the past decade, advances in control of the fruiting cycle of guava, *Psidium guajava* L., resulted in the establishment of orchards in various locations throughout Hawaii (Shigeura et al. 1975, Shigeura and Bullock 1983). In 1975, the occurrence of the transparentwinged plant bug, *Hyalopeplus pellucidus* (Stål) (Hemiptera: Miridae), in orchards was associated with widespread abscission of guava buds on the island of Hawaii (Shigeura and Bullock 1983).

H. pellucidus is one of the largest mirid species in Hawaii, and it occurs on all islands from sea level to the mountains (Kirkaldy 1902, Zimmerman 1948). Recorded host plants include *Acacia koa* Gray, *Chenopodium, Coffea arabica* L., *Coprosma, Dodonaea, Hibiscus, Metrosiderous, Persea americana* Mill., *Psidium guajava* L., *Pipturus, Sida,* and *Straussia* (Beardsley 1966, Fullaway and Krauss 1945, Lucas 1940, Kirkaldy 1907). Aside from reports of its host associations and the description of the last two nymphal instars by Kirkaldy (1907), there is relatively little known about this insect. Fullaway and Krauss (1945) reported that this polyphagous mirid was common on *Hibiscus* in Honolulu and that large numbers occurred on imported guava on the lower mountain slopes. Although this plant bug was thought to be predaceous by Kirkaldy (1907), Fullaway and Krauss (1945) speculated that it might be phytophagous.

Since certain mirids in the genus *Lygus* are serious pests of cultivated crops, we sought to determine the pest status and importance of *H. pellucidus* to commercial production of guava. We report here the results of studies on the development of *H. pellucidus* and damage caused by its feeding on guava flower buds.

---

[1]HEMIPTERA: Miridae

[2]Journal Series No. 3310 of the Hawaii Institute of Tropical Agriculture and Human Resources.

[3]Mailing Address. Department of Entomology, University of Hawaii, 3050 Maile Way, Honolulu, Hawaii 96822.

[4]Mailing Address. P. O. Box 4459, Hilo, Hawaii 96720.

MATERIALS AND METHODS

In commercial guava orchards the fruiting cycle was usually induced by selective pruning of the branches followed by fertilization and, if needed, irrigation. This practice induced vegetative flush. Flower buds were initiated on some of the new vegetative growth and these succulent twigs were called fruiting twigs by guava producers. In this paper the term fruiting twig refers to the apical portion of the new shoot that includes the flower buds.

Collection and Incubation of Eggs. The following procedures were used to obtain eggs for the incubation study. Adults (Figure 3D) were collected in guava orchards, sexed by examining the abdominal sternites (Figure 1), and placed in cages containing freshly cut fruiting twigs for 7 days. A ratio of 2-3 males to each female was used. At 2- to 3-day intervals, the fruiting twig was changed and honey was streaked onto the sides of the cages. Gravid females were then caged in the field (Figure 2), on guava flower buds which did not contain eggs, for 24 hours, after which the buds were examined for eggs. An alternative method was to cage mature females with *Jatropha hastata* inflorescences that contained flower buds. We could not rear adults solely on guava foliage and found that it was necessary to provide honey as a supplemental food source.

Buds containing eggs were incubated at 26.7 °C for one day prior to dissection. This practice allowed the chorion to harden and helped reduce the incidence of mechanical injury to eggs during dissection. Upon dissection from the buds, eggs were sterilized in 10% sodium hypochlorite solution for 5 seconds, rinsed in sterile distilled water and incubated at 26.7 ± 1 °C in covered petri dishes on a selective agar medium containing antifungal and antibiotic agents (Ko et al. 1978). The eggs were observed daily for embryonic development and eclosion.

Egg Measurements. Twenty-five eggs were examined using a dissecting microscope. The eggs were placed on a microscope slide and measured using an ocular micrometer at 50× magnification. Measurements were made of egg length (from the basal end to the operculum), width at the widest point, and length of the waxy structure surrounding the operculum.

Nymphal Food Requirements. Before proceeding with the determination of nymphal stadia, we conducted an experiment to determine whether the nymphs could survive without flower buds. Fruiting twigs with a minimum of 2 flower buds were cut below the sixth leaf node. Flower buds were removed from 20 of the terminals, and the terminals were sorted into two treatment groups based on the presence or absence of flower buds. The cut end of each stem was pushed through a tight-fitting hole in the bottom of a pint-sized paper cup, and the stem was immersed in a container of water beneath the cup. A single second- or third-instar nymph was placed on each terminal before placing a tight fitting lid on the cup. Nymphs in each treatment group were observed daily for development and mortality. Food and water was changed every 3-4 days.

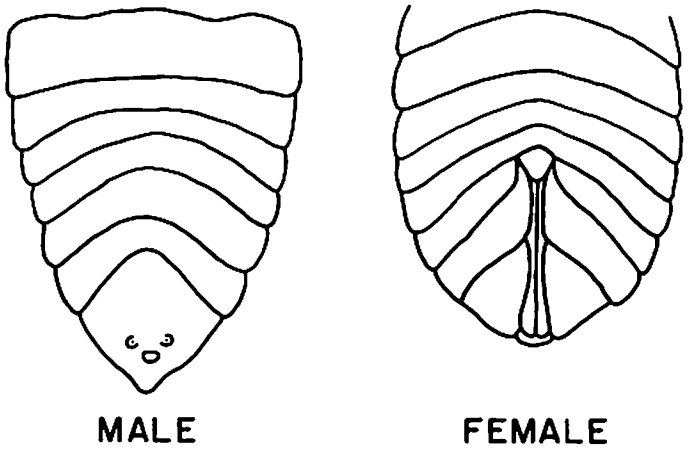

FIGURE 1. Morphological differences in the abdominal sternites of male and female *Hyalopeplus pellucidus*.

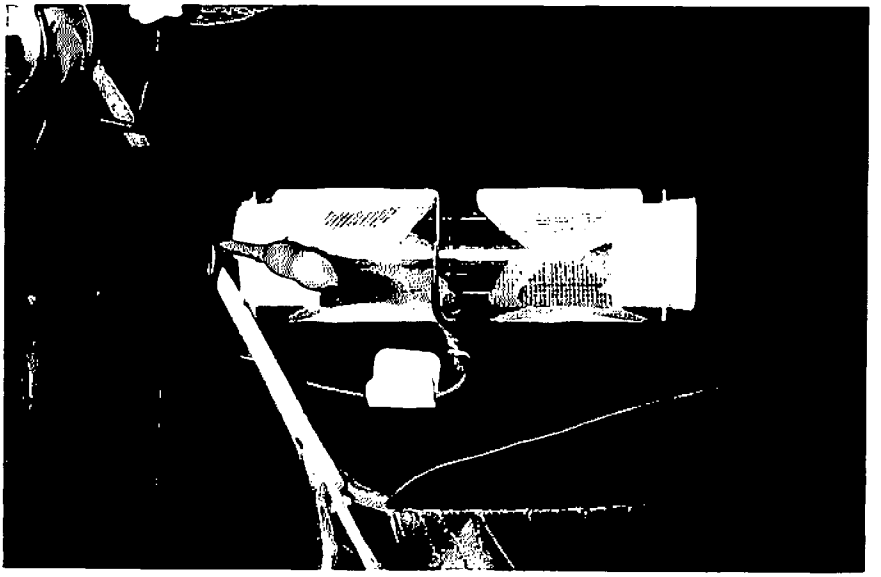

FIGURE 2. Acrylic sleeve cage used to cage *Hyalopeplus pellucidus* on guava buds.

Nymphal Development. Fruiting twigs bearing *H. pellucidus* eggs were collected and placed in paper cups and examined daily for egg hatch. Newly hatched nymphs were caged singly on guava buds and observed daily for molting. The nymphs were transferred to fresh guava buds every 3 days.

Feeding Injury to Flower Buds. Partially abscised guava flower buds were examined to determine the extent of feeding and oviposition injury. Two separate collections of fifty buds each were made from a guava, 'Beaumont' cultivar, at the University of Hawaii Waiakea Experimental Station, in June and July 1980. The buds were examined using a dissecting microscope, and data on oviposition and mirid feeding injury were collected. No peduncles were collected with the abscised buds since abscission occurred at the peduncle-ovary juncture.

Because the observations of abscised buds showed that feeding injury was a probable cause of abscission, cage tests were conducted using nymphal instars 1-4 and adults. To obtain undamaged flower buds for the study, cloth-sleeve cages were placed over fruiting twigs to protect recently differentiated flower buds from *H. pellucidus* feeding. Flower buds were monitored every 3-4 days until the buds developed to the stage where the diameter of the ovary was about equal to that of the corolla. The cloth sleeve cage was then removed, and an acrylic plastic sleeve cage was fitted over each of two or three of the buds at the same leaf node (Figure 2). Depending on the availability of specific nymphal instars, these studies compared feeding injury of one or two stages against an undamaged check at the same leaf node. Two nymphs of a specific instar, or an adult, were placed in each of the cages. The remaining caged bud served as the untreated check. The insects were removed from the cages after two days, and the caged buds were observed for abscission. Observations ended when flowering occurred.

RESULTS

Egg Stage. The eggs are elongate, slightly curved and have a white waxy structure covering the operculum (Figure 3A). Eggs averaged 1.80 mm (sd = 0.11) in length and 0.42 mm (sd = 0.02) in width (n = 25). The mean length of the filament was 0.19 mm (sd = 0.04).

Eggs were deposited predominately in succulent guava stems and flower buds but were sometimes deposited in midribs on the abaxial leaf surface. In situ, only the white waxy structure attached to the operculum was readily discernible (Figure 3B). Information on the distribution of eggs on guava will be reported in a later paper.

Egg Incubation Period. Of 134 eggs that were incubated, only 20 (15%) hatched. The average incubation period was 7.1 days (range = 6-8 days). Of the remaining eggs, 20 (15%) were not viable due to bacterial contamination, 8 (6%) because of fungal contamination, 5 (4%) because of mechanical injury, and 56 (42%) because of infertility. Twenty-five (19%)

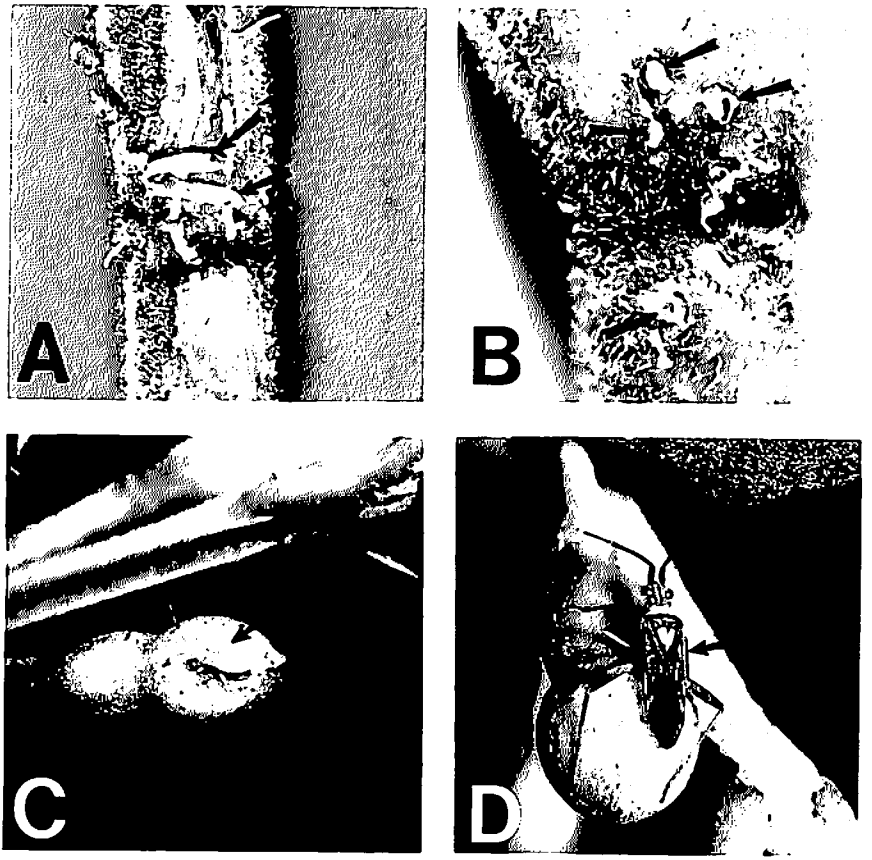

FIGURE 3. *Hyalopeplus pellucidus*. A, eggs dissected from a guava stem; B, eggs in a guava flower bud; C, nymph on guava flower bud; D, adult on guava flower bud.

of the eggs developed until eclosion, but the nymphs could not emerge completely and died in the process.

Nymphal Food Requirements. Although the sample size was small, results of the experiment showed that flower buds were a required food source of *H. pellucidus*, which explains nymphal predilection for buds in the field. Seventy-five percent of the nymphs (n = 16) in the with-buds treatment developed into adults, whereas none (n = 14) of the nymphs in the without-buds treatment did so. Four of the nymphs in the with-buds treatment and 6 of the nymphs in the without-buds treatment escaped prior to completion of the experiment and were not used in calculating the results.

Nymphal Development. There were 5 nymphal instars. Development was rapid, as each stadium was completed in 2-4 days. The first nymphal stadium was completed in an average of 2.7 days (sd = 0.9; n = 77); the second in 1.9 days (sd = 0.8; n = 57); the third in 2.3 days (sd = 0.9;

n = 51); the fourth in 3.3 days (sd = 1.3; n = 44); and the fifth stadium in 3.6 days (sd = 0.7; n = 28). The total duration of nymphal development was about 14 days.

Feeding Injury to Flower Buds. Examination of the 2 collections of abscised buds strongly suggested that abscission may have resulted from extensive damage to developing anthers within the corolla portion of the flower bud. All of the buds exhibited feeding injury characterized by a necrotic blackening of anthers, but there was no visible damage to the ovaries (Figure 4).

Strong (1970) reported similar injury by another mirid, *Lygus hesperus* Knight. He determined that the necrosis was due primarily to digestion of tissue by the enzyme polygalacturonase and not to laceration of the tissues by the stylets. He believed that the enzymatic destruction of auxin-producing tissue of the developing bud resulted in a rise in the levels of plant hormones directly associated with formation of the abscission layer.

There was little evidence to suggest that bud abscission was induced by oviposition injury. Only 16% and 26% of the abscised buds from the first and second collections, respectively, contained eggs, and thus, there was no direct relationship between oviposition and abscission.

To establish the cause and effect relationship between insect feeding and flower bud abscission, different stages of the mirid were caged on

FIGURE 4. Comparison of injury to guava flower buds caused by the feeding of *Hyalopeplus pellucidus* nymphs. A, Undamaged bud; B, Slightly damaged bud; C, Highly damaged and abscised bud.

TABLE 1. Induced Abscission of Guava Flower Buds by the Transparentwinged Plant Bug, *Hyalopeplus pellucidus* (Stål).

Mirid Stage	Total Buds	Cumulative Total of Abscised Buds[1]						Percent Abscised Buds
		3 Day	1 Wk	2 Wk	3 Wk	4 Wk	5 Wk	
N-1	18	0	2	2	3	—	—	17%
N-2	15	—	2	8	9	10	11	73%
N-3	21	9	18	18	18	—	—	86%
N-4	5	—	1	2	3	3	5	100%
Adult	17	—	0	3	3	5	—	29%
Check	37	0	0	0	0	0	0	0%

[1]Abscission counts ended when the buds flowered.

developing buds. The results of this experiment demonstrated conclusively that *H. pellucidus* feeding injury caused abscission of the flower buds (Table 1). Dissection and examination of abscised buds showed the same type of injury we observed earlier in field collections of abscised buds. The results also showed that feeding by the second, third, and fourth nymphal stages was more likely to cause abscission than feeding by the first instar nymphs or adults. The exact reason for this difference is unknown, but could be due to the shorter stylets of first-instar nymphs or due to lower rates of harmful enzyme secretions by adults. The results also suggest that the developing anthers are important in auxin production, and that injury to the anthers was the primary cause for bud abscission.

Field Observations. It is understandable why there has been confusion about whether this insect is predaceous or phytophagous. Although adults were wary and not easily approached, we were able to observe their habits from a distance. The adults were not commonly found in guava orchards until flower buds became abundant. We did not often observe them feeding on guava foliage, stems or flower buds, and their food preferences were not determined.

On the other hand, *H. pellucidus* nymphs (Figure 3C) were definitely anthophagous. They were almost always observed feeding on flower buds, and were rarely found elsewhere on the trees. Like the adults, the nymphs were wary and quick to move to the opposite side of the buds when observed at a close distance. Nymphs were reluctant to leave buds, even when provoked with a twig.

Our surveys of flowering shrubs and trees in the vicinity of guava orchards at Pahoa, Kurtistown, Panaewa, Ainaola, and Hilo, Hawaii resulted in the identification of additional host plants. All stages of *H. pellucidus* were observed on the inflorescences of *Jatropha hastata* Jacq., *Psidium cattleianum* Sabine, and *Trema orientalis* (L.) Bl. Eggs, nymphs, and adults were particularly numerous on *J. hastata*. Eggs were also observed on *Melochia indica* A. Gray.

DISCUSSION

The incubation period for *H. pellucidus* eggs was difficult to determine. We were unsuccessful in obtaining oviposition in fruiting twigs in the laboratory and had to resort to caging adults in the field. Furthermore, eggs had to be dissected from oviposition sites and incubated on agar because the apical growth of guava containing eggs deteriorated in the laboratory before hatching occurred. Dissected eggs were initially incubated on 2% agar, but we later used a selective antifungal and antibiotic agar medium because of the effects of bacterial and fungal contamination on incubation. Despite providing a 3:1 male:female ratio, the occurrence of a high percentage of unfertilized eggs suggested that we were unsuccessful in getting adults to mate in the laboratory.

This study established that *H. pellucidus* is an important pest of cultivated guava. Our observations showed that the insect successfully developed on guava and that feeding injury of the nymphal stages caused abscission of flower buds. Since harvesting is the most labor-intensive part of guava production, growers have adopted the practice of dividing their orchards into separate production units. The fruiting cycles of the production units are initiated in sequence. This practically assures that there will be flower buds in the orchard throughout the year, and for this reason, we believe that *H. pellucidus* will become a common pest in guava orchards. Further research on the temporal distribution of this insect in guava orchards is needed to provide a sound basis for developing pest management strategies.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance of Randall Hamasaki, Preston Kushi, Jake Marley and Janice Nagata for help in collecting and rearing. We also thank Alfred G. Wheeler, Jr., Pennsylvania Department of Agriculture, for critically reading the manuscript.

REFERENCES CITED

Beardsley, J. W. 1966. Insects and other terrestrial arthropods from the leeward Hawaiian Islands. Proc. Hawaii. Entomol. Soc. 19:157-85.

Fullaway, D. T. and N. L. H. Krauss. 1945. Common Insects of Hawaii. Tongg Publishing Company, Honolulu, Hawaii. 228 p.

Gagne, W. C. 1976. Canopy-associated arthropods in *Acacia koa* and *Metrosiderous* tree communities along the Mauna Loa transect. Technical Report No. 77. U.S. International Biological Program.

Kirkaldy, G. W. 1902. Hemiptera. p. 143. *In* D. Sharp (ed.) Fauna Hawaiiensis, Volume III, Part 2, Cambridge University Press, Cambridge.

_____. 1907. Biological notes on the Hemiptera of the Hawaiian Isles. Proc. Hawaii. Entomol. Soc. 1:135-161.

Ko, W. H., H. S. Chang, and H. J. Su. 1978. Isolates of *Phytophthora cinnamomi* from Taiwan as evidence for an Asian origin of the species. Trans. Br. Mycol. Soc. 71:496-99.
Lucas, E. 1940. Notes and exhibitions. Proc. Hawaii. Entomol. Soc. 10:354.
Shigeura, G. T. and R. M. Bullock. 1983. Guava (*Psidium guajava* L.) in Hawaii — History and production. Research extension series 35, College of Tropical Agriculture and Human Resources. 28 p.
Shigeura, G. T., R. M. Bullock, and J. A. Silva. 1981. Defoliation and fruit set in guava. HortScience 10:509.
Strong, F. E. 1970. Physiology of injury caused by *Lygus hesperus*. J. Econ. Entomol. 63:808-814.
Zimmerman, E. C. 1948. Insects of Hawaii. Volume 3. Heteroptera. University of Hawaii Press, Honolulu. 255 p.